

CMPT385 Final Exam

Three Hours

Closed Book. No calculators.

December 11, 2004, 2.00pm

Important Instructions:

Read each question before you answer it. Marks cannot be awarded if you answer some other question.

Indicate your answers clearly.

Please, no ultra hard pencil submissions.

Marks will be awarded for the style and clarity of your answer.

1. Transformations (35 marks)

For the following, assume 2 dimensions, and that points are represented as column vectors. Thus, the modelview matrix is initially an identity matrix, and calls to *glTranslate()* and *glRotate()* result in a right multiplication of the modelview matrix by a transformation matrix.

- (3) Show the matrix representation for a translation of (dx, dy) in this system.
- (3) Show the matrix representation for a rotation of Θ about the origin in this system.
- (5) Show that any two translation transformations are commutative.
- (5) Show the modelview matrix after a translation of (dx, dy) followed by a rotation of Θ . Assume the modelview matrix initially was the identity matrix.
- (5) Show the result from the preceding if the transformations are done in the opposite way.
- (9) Suppose you have a fragment of code as follows:

```
glTranslate ( 15, 30);  
glRotate( 60, 0, 0, 1); // i.e., about the origin.
```

Given that $\sin(60) = 0.866025$, and $\cos(60) = 0.5$, show how to rewrite the above as

```
glRotate( XXX, 0, 0, 1);  
glTranslate( YYY, ZZZ );
```

so that the net transformation is the same.

- (5) Show a *reflection* transformation matrix (2D), that reflects an object about the Y axis.

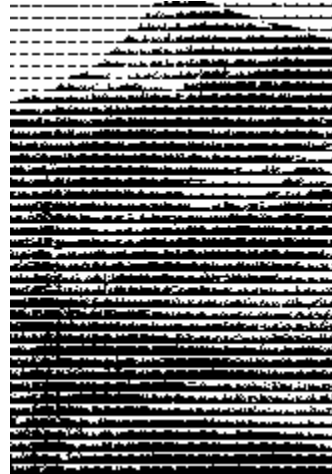
2. Geometric Primitives (20 marks)

- (3) Consider the implicit function of the plane $Ax + By + Cz + D = 0$. Give an expression for the surface normal of this surface.
- (12) Define a polygon by a sequence of points P_0, P_1, \dots, P_N . Give an algorithm that shows that this polygon contains no intersecting edges.
- (5) Give an algorithm to triangulate a convex polygon.

3. **Halftoning** (10 marks)

The following matrix could be used as a dither matrix for the halftoning assignment you did in this class. It is called a “line halftone” and creates the output shown beside the data:

```
{ {36, 35, 34, 33, 32, 31},  
  {30, 29, 28, 27, 26, 25},  
  {24, 23, 22, 21, 20, 19},  
  {18, 17, 16, 15, 14, 13},  
  {12, 11, 10, 9, 8, 7},  
  { 6, 5, 4, 3, 2, 1}};
```



The dither matrix above is very similar to the line halftone matrix used in your assignment. It is called a line matrix because there is an effect of lines crossing the image. Show how to create a line matrix that creates a diagonal line effect as follows:



4. **Incremental Algorithms** (15 marks) Develop a midpoint line drawing algorithm that for lines with slopes between 0 and -1, where new points are drawn to either the E or SE of a current pixel. *Clearly indicate* the initial value of the decision variable and how it is updated as the line is drawn. You can present your solution in C, or in *clear algorithmic notation*.

5. **Short answer** (20 marks) Answer any four of the following.
- What is a shadow map, and how is it used?
 - Give the radiosity equation, and explain the purpose of each term.
 - Explain how the z buffer works when enabled. What happens when it is not enabled? (That is, what will the viewer of the scene see?)
 - Using the approach taken in class to splines, develop a blending matrix for a straight line.
 - Explain how you might implement *gluLookAt()*. (Your answer should have a clear explanation of the approach you would use.)
 - Explain two uses of the accumulation buffer.

6. (This is **optional**)(2 marks)

I have found that students learn what is taught at the beginning of a course best, and what is taught at the end least. The earlier material gets tested with a midterm, with assignments, etc.

When I've taught this class in the past, I started with the incremental algorithms, and then progressed to other topics. This meant that assignments involving models and lighting come late in the term.

This year, I taught modeling, camera and lighting at the beginning, and did incremental algorithms last. I felt this would overall give students the best learning experience.

My question is:

- From a learner's point of view, was this a good decision? Or, would it have been better to know what was going on in the raster when learning the high level material?

This is the end of this exam.